

CLAIMS

1. A method for electrolytically forming a material which comprises at least two elements, the method comprising:

5 providing an electrolytic cell comprising a cathode, an anode, and an electrolytic solution extending between the cathode and the anode; and
 electrolytically forming a metallic product with the electrolytic cell, the forming comprising primarily electrorefining of a first element of the at least two elements and primarily electrowinning of a second element of the at least
 10 two elements; the metallic product comprising the first and second elements.

2. The method of claim 1 wherein the electrolytic cell comprises two anodes; one of the two anodes comprising the first element, and the other of the two anodes not comprising the first element.

3. The method of claim 1 wherein the metallic product is formed on the cathode.

4. The method of claim 1 wherein one of the first and second elements comprises titanium.

5. The method of claim 1 wherein one of the first and second elements comprises titanium and the other of the first and second elements comprises hafnium.

6. The method of claim 1 wherein one of the first and second elements comprises titanium and the other of the first and second elements comprises zirconium.

7. The method of claim 1 wherein one of the first and second elements comprises titanium and the other of the first and second elements comprises vanadium.

8. The method of claim 1 wherein one of the first and second elements comprises titanium and the other of the first and second elements comprises aluminum.
9. The method of claim 1 wherein one of the first and second elements comprises titanium and the other of the first and second elements comprises chromium.
10. The method of claim 1 wherein one of the first and second elements comprises tantalum and the other of the first and second elements comprises zirconium.
11. The method of claim 1 wherein one of the first and second elements comprises tantalum and the other of the first and second elements comprises chromium.
12. The method of claim 1 wherein one of the first and second elements comprises tantalum and the other of the first and second elements comprises nickel.
13. The method of claim 1 wherein one of the first and second elements comprises tantalum.
14. The method of claim 1 wherein one of the first and second elements comprises titanium and wherein the other of the first and second elements comprises tantalum.
15. The method of claim 1 wherein the first element comprises titanium and wherein the second element comprises tantalum.
16. The method of claim 1 wherein the first element comprises tantalum and wherein the second element comprises titanium.

17. The method of claim 1 further comprising shaping the metallic product into a physical vapor deposition target.
18. The method of claim 17 wherein the shaping comprises melting the metallic product into an ingot, and shaping the ingot into a physical vapor deposition target.
19. A method for electrolytically forming a material which comprises at least two elements, the method comprising:
- providing an electrolytic cell comprising a cathode, at least two anodes, and an electrolytic solution extending between the cathode and the at least two anodes; the at least two anodes comprising first and second anodes having different concentrations of a first element relative to one another; the electrolytic solution comprising a compound which includes a second element; and
- electrolytically forming a metallic product with the electrolytic cell; the metallic product comprising a mixture of the first and second elements.
20. The method of claim 19 wherein the first anode has a concentration of the first element which is greater than 0 weight percent; and wherein the second anode has a concentration of the first element which is about 0 weight percent.
21. The method of claim 19 further comprising providing a first electrical potential difference between the first anode and the cathode and a second electrical potential difference between the second anode and the cathode; and wherein the second electrical potential difference is different than the first electrical potential difference.
22. The method of claim 19 wherein the first element is a metallic element; wherein the first anode consists essentially of the first element; and wherein the second anode predominately comprises carbon.

23. The method of claim 19 further comprising shaping the metallic product into a physical vapor deposition target.

5 24. A method for electrolytically forming a material which comprises at least two elements, the method comprising:

providing an electrolytic cell comprising a cathode, at least two anodes, and an electrolytic solution extending between the cathode and the at least two anodes; the electrolytic solution comprising a compound which includes a
10 second element; and

electrolytically forming a metallic product with the electrolytic cell; the metallic product comprising a mixture of the first and second elements; one of the at least two anodes being operated at a different voltage than an other of the at least two anodes during the electrolytically forming of the metallic product.

15 25. The method of claim 24 further comprising shaping the metallic product into a physical vapor deposition target.

20 26. A method for electrolytically forming a product which comprises a mixture of tantalum and titanium, the method comprising:

providing an electrolytic cell comprising a cathode, an anode, and an electrolytic solution extending between the cathode and the anode; the anode comprising titanium and the electrolytic solution comprising a tantalum-containing compound; and

25 electrolytically forming a metallic product with the electrolytic cell, the metallic product comprising a mixture of titanium from the anode and tantalum from the tantalum-containing compound.

27. The method of claim 26 wherein the tantalum-containing compound is K_2TaF_7 .

28. The method of claim 26 wherein the electrolytic solution is maintained at a temperature of from about 700°C to about 850°C during the electrolytically forming of the metallic product.

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29. The method of claim 26 wherein the electrolytic solution is maintained at a temperature of from about 700°C to about 750°C during the electrolytically forming of the metallic product.

10 30. The method of claim 26 further comprising shaping the metallic product into a physical vapor deposition target.

31. The method of claim 26 further comprising pressing and sintering the metallic product.

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32. The method of claim 26 further comprising subjecting the metallic product to forces to reduce an average grain size present within the metallic product.

33. A material which comprises a mixture of tantalum and titanium; and which is at least 99.9 weight percent tantalum and titanium.

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34. The material of claim 33 comprising at least about 50 weight percent titanium.

35. The material of claim 33 comprising greater than 0 weight percent tantalum and less than or equal to about 12 weight percent tantalum.

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36. The material of claim 33 comprising greater than or equal to about 7 weight percent tantalum and less than or equal to about 12 weight percent tantalum.

37. The material of claim 33 being in the shape of a PVD target.
38. A material which consists essentially of a mixture of tantalum and titanium.
- 5 39. The material of claim 38 being in the shape of a PVD target.
40. The material of claim 38 comprising more titanium than tantalum.
41. The material of claim 38 comprising more tantalum than titanium.
- 10 42. A material which consists essentially of:
- at least one first element selected from the group consisting of titanium, tantalum, zirconium, hafnium, and niobium;
- at least one second element selected from the group consisting of titanium, tantalum, zirconium, hafnium, niobium, vanadium, aluminum, chromium and nickel; and
- 15 wherein the at least one first element is different from the at least one second element.
- 20 43. The material of claim 42 wherein the first and second elements together define an alloy within the material.
44. The material of claim 42 comprising tantalum to a concentration of greater than or equal to about 5 weight percent and less than or equal to about 95 weight percent.
- 25 45. The material of claim 42 comprising tantalum to a concentration of greater than or equal to about 5 weight percent and less than or equal to about 25 weight percent.

46. The material of claim 42 comprising tantalum to a concentration of greater than or equal to about 25 weight percent and less than or equal to about 50 weight percent.
47. The material of claim 42 comprising tantalum to a concentration of greater than or equal to about 50 weight percent and less than or equal to about 75 weight percent.
48. The material of claim 42 comprising tantalum to a concentration of greater than or equal to about 75 weight percent and less than or equal to about 95 weight percent.
49. The material of claim 42 comprising titanium to a concentration of greater than or equal to about 5 weight percent and less than or equal to about 95 weight percent.
50. The material of claim 42 comprising titanium to a concentration of greater than or equal to about 5 weight percent and less than or equal to about 25 weight percent.
51. The material of claim 42 comprising titanium to a concentration of greater than or equal to about 25 weight percent and less than or equal to about 50 weight percent.
52. The material of claim 42 comprising titanium to a concentration of greater than or equal to about 50 weight percent and less than or equal to about 75 weight percent.
53. The material of claim 42 comprising titanium to a concentration of greater than or equal to about 75 weight percent and less than or equal to about 95 weight percent.
54. The material of claim 42 comprising hafnium to a concentration of greater than or equal to about 5 weight percent and less than or equal to about 95 weight percent.

55. The material of claim 42 comprising hafnium to a concentration of greater than or equal to about 5 weight percent and less than or equal to about 25 weight percent.

56. The material of claim 42 comprising hafnium to a concentration of greater than
5 or equal to about 25 weight percent and less than or equal to about 50 weight percent.

57. The material of claim 42 comprising hafnium to a concentration of greater than or equal to about 50 weight percent and less than or equal to about 75 weight percent.

10 58. The material of claim 42 comprising hafnium to a concentration of greater than or equal to about 75 weight percent and less than or equal to about 95 weight percent.

59. The material of claim 42 comprising niobium to a concentration of greater than or equal to about 5 weight percent and less than or equal to about 95 weight percent.

15 60. The material of claim 42 comprising niobium to a concentration of greater than or equal to about 5 weight percent and less than or equal to about 25 weight percent.

61. The material of claim 42 comprising niobium to a concentration of greater than
20 or equal to about 25 weight percent and less than or equal to about 50 weight percent.

62. The material of claim 42 comprising niobium to a concentration of greater than or equal to about 50 weight percent and less than or equal to about 75 weight percent.

25 63. The material of claim 42 comprising niobium to a concentration of greater than or equal to about 75 weight percent and less than or equal to about 95 weight percent.

64. The material of claim 42 comprising zirconium to a concentration of greater than or equal to about 5 weight percent and less than or equal to about 95 weight percent.
- 5 65. The material of claim 42 comprising zirconium to a concentration of greater than or equal to about 5 weight percent and less than or equal to about 25 weight percent.
66. The material of claim 42 comprising zirconium to a concentration of greater
10 than or equal to about 25 weight percent and less than or equal to about 50 weight percent.
67. The material of claim 42 comprising zirconium to a concentration of greater
15 than or equal to about 50 weight percent and less than or equal to about 75 weight percent.
68. The material of claim 42 comprising zirconium to a concentration of greater
20 than or equal to about 75 weight percent and less than or equal to about 95 weight percent.
69. The material of claim 42 being in the shape of a PVD target.
70. A PVD target comprising tantalum to a concentration of greater than or equal to about 5 weight percent and less than or equal to about 95 weight percent.
- 25 71. The PVD target of claim 70 comprising the tantalum to a concentration of less than or equal to about 50 weight percent.

72. The PVD target of claim 70 consisting essentially of tantalum and titanium.